R E P O R T  R E S U M E S

ED 013 293 VT 000 622

PROPAGATING HORTICULTURAL PLANTS. HORTICULTURE-SERVICE OCCUPATIONS, MODULE NO. 3.

OHIO STATE UNIV., COLUMBUS, CENTER FOR VOC. EDUC.
REPORT NUMBER OSU-AGDEX-200-017-3 PUB DATE AUG 65
EDRS PRICE MF-$0.25 HC-$2.32 58P.

DESCRIPTORS- *TEACHING GUIDES, UNITS OF STUDY (SUBJECT FIELDS), *VOCATIONAL AGRICULTURE, *ORNAMENTAL HORTICULTURE OCCUPATION, *PLANT PROPAGATION, *HORTICULTURE, HIGH SCHOOLS, BIBLIOGRAPHIES,

ONE OF A SERIES DESIGNED TO PREPARE HIGH SCHOOL STUDENTS FOR HORTICULTURE SERVICE OCCUPATIONS, THIS GUIDE HAS AS ITS MAJOR OBJECTIVE TO DEVELOP AN UNDERSTANDING OF VARIOUS PLANT PROPAGATION METHODS AND AN ABILITY TO CARRY OUT CERTAIN PROPAGATION PROCEDURES. IT WAS DEVELOPED BY A NATIONAL TASK FORCE ON THE BASIS OF DATA FROM STATE STUDIES. SUBJECT MATTER AREAS ARE (1) PRODUCING PLANTS FROM SEEDS, (2) PRODUCING PLANTS FROM CUTTINGS, (3) PRODUCING PLANTS FROM LAYERAGE, (4) PROPAGATING BY BUDDING AND GRAFTING METHODS, AND (5) BUILDING PROPAGATION CONTAINERS AND EQUIPMENT. SUGGESTIONS FOR INTRODUCTION OF THE MODULE, SPECIFIC UNIT OBJECTIVES, SUBJECT MATTER CONTENT, TEACHING-LEARNING ACTIVITIES, INSTRUCTIONAL MATERIALS, AND REFERENCES, AND EVALUATIVE CRITERIA ARE INCLUDED. THE MODULE IS SCHEDULED FOR 30 HOURS OF CLASS INSTRUCTION, 70 HOURS OF LABORATORY EXPERIENCE, AND 50 HOURS OF OCCUPATIONAL EXPERIENCE. TEACHERS WITH A BACKGROUND IN HORTICULTURE MAY USE IT AS A GUIDE FOR DEVELOPING A UNIT FOR LESS ABLE HIGH SCHOOL STUDENTS WITH AN OCCUPATIONAL GOAL IN ORNAMENTAL HORTICULTURE. THIS DOCUMENT IS AVAILABLE FOR A LIMITED PERIOD AS PART OF A SET (VT 000 619 - 000 631) FOR $7.25 FROM THE CENTER FOR VOCATIONAL AND TECHNICAL EDUCATION, THE OHIO STATE UNIVERSITY, 980 KINNEAR ROAD, COLUMBUS, OHIO 43212. (JM)

ED013293

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

I. R. D.

Agdex
200
017

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

# PROPAGATING HORTICULTURAL PLANTS

One of Twelve Modules in the Course Preparing for Entry in

**HORTICULTURE - SERVICE OCCUPATIONS**

Module No. 3

The Center for Research and Leadership Development
in Vocational and Technical Education

The Ohio State University
980 Kinnear Road
Columbus, Ohio, 43212

The development of these materials was supported by a grant
from the
Division of Adult and Vocational Research
United States Office of Education

August, 1965

VT000622

M E M O R A N D U M

TO: The ERIC Clearinghouse on Vocational and Technical Education
The Ohio State University
980 Kinnear Road
Columbus, Ohio 43212

FROM: (Person) James W. Hensel (Agency) The Center for Vocational and Technical Education

(Address) 980 Kinnear Road, Columbus, Ohio 43212

DATE: August 7, 1967

RE: (Author, Title, Publisher, Date) Module No. 3, "Propagating Horticultural Plants," The Center for Vocational and Technical Education, August, 1965.

Supplementary Information on Instructional Material

Provide information below which is not included in the publication. Mark N/A in each blank for which information is not available or not applicable. Mark P when information is included in the publication. See reverse side for further instructions.

(1) Source of Available Copies:
Agency The Center for Vocational and Technical Education
Address 980 Kinnear Road, Columbus, Ohio 43212
Limitation on Available Copies No Limit Price/Unit $7.25/set
(quantity prices)

(2) Means Used to Develop Material:
Development Group National Task Force
Level of Group National
Method of Design, Testing, and Trial Part of a funded project of the USOE, OE-5-85-009; materials based on research from state studies; see preface material in the course outline.

(3) Utilization of Material:
Appropriate School Setting High School
Type of Program High school class in horticulture--service occupations
Occupational Focus Service workers at nurseries, garden centers, greenhouses, etc.
Geographic Adaptability Nationwide
Uses of Material Instructor course planning
Users of Material Teachers

(4) Requirements for Using Material:
Teacher Competency Background in horticulture
Student Selection Criteria Designed for the less able high school student, goal in horticulture service occupations.
Time Allotment Estimated time listed in module. (P)

Supplemental Media --
Necessary x
Desirable
(Check Which)

Describe Suggested references given in module. (P)

Source (agency)
(address)

# PROPAGATING HORTICULTURAL PLANTS

## CONTENTS


| | Page |
|---|---|
| Suggestions for Introducing the Module | 1 |
| Competencies to be Developed | |
| I. To develop in the student the ability to produce plants from seeds | 4 |
| II. To develop in the student the ability to product plants from cuttings | 23 |
| III. To develop in the student the ability to produce plants by layerage | 33 |
| IV. To develop in the student an understanding of budding and grafting as methods of plant propagation | 39 |
| V. To develop in the student the ability to build containers and equipment required for plant propagation | 45 |
| Suggestions for Evaluating Educational Outcomes of the Module | 49 |
| Sources of Suggested Instructional Materials and References | 50 |

# PROPAGATING HORTICULTURAL PLANTS

## Major Teaching Objective

To develop in students an understanding of the various methods of which plants are propagating and to develop the individual's ability to carry out certain propagating procedures.

## Suggested Time Allotment

| | | |
|---|---|---|
| At school | | |
| Class instruction | 30 hours | |
| Laboratory experience | 70 hours | |
| Total at school | | 100 hours |
| Occupational experience | | 50 hours |
| Total for module | | 150 hours |

## Suggestions for Introducing the Module

1. Discuss the module content with the students informing them of what will be the expected performance and activities during the study of this module. It is important that the teacher keep his terminology simple and work with the students in outlining course content.

2. Provide displays of sexual and asexual reproduction in various phases of maturity from the initial stage to a growing plant. Suggestions for display:

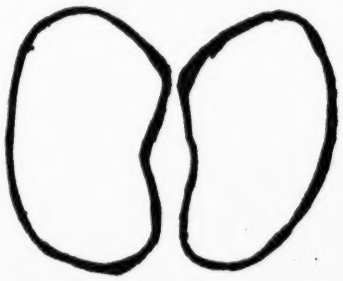
| Sexual | Asexual |
|---|---|
| Lima bean | Bulbs (onion, tulip, lily) |
| Corn | Corms (crocus, gladiolus) |
| Avocado | Cuttings (Taxus, Juniperus) |
| Radish | Leaf plantings (air plant-Bryophyllum) |
| Coconut | Stolons (certain grasses) |
| | Layering (rubber plant, philodendron, honeysuckle) |

Suggested arrangement:

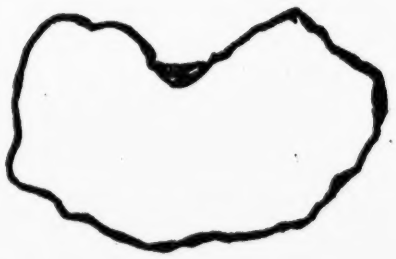
## LIMA BEAN DISPLAY

Dry Bean

Split Dry Bean

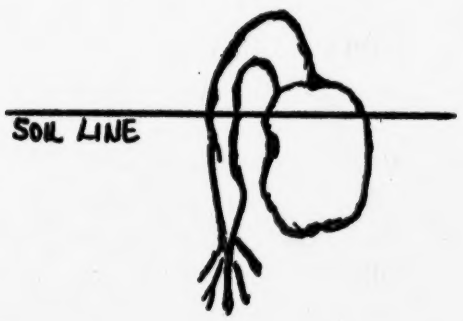


Soaked Bean (1 day)

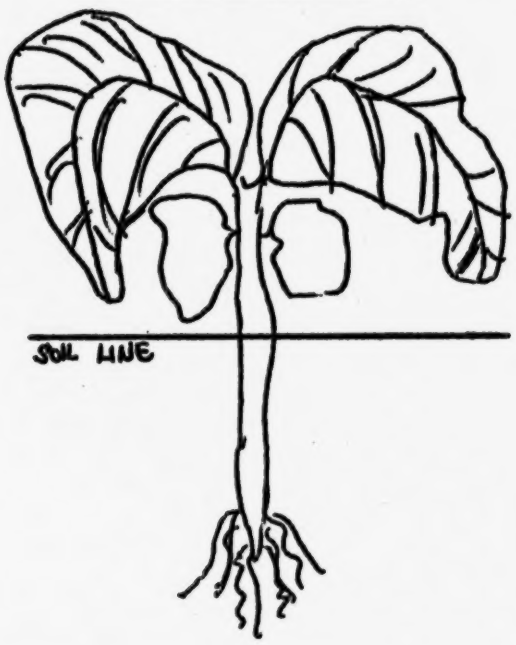


Split-Germinated
(3 day)

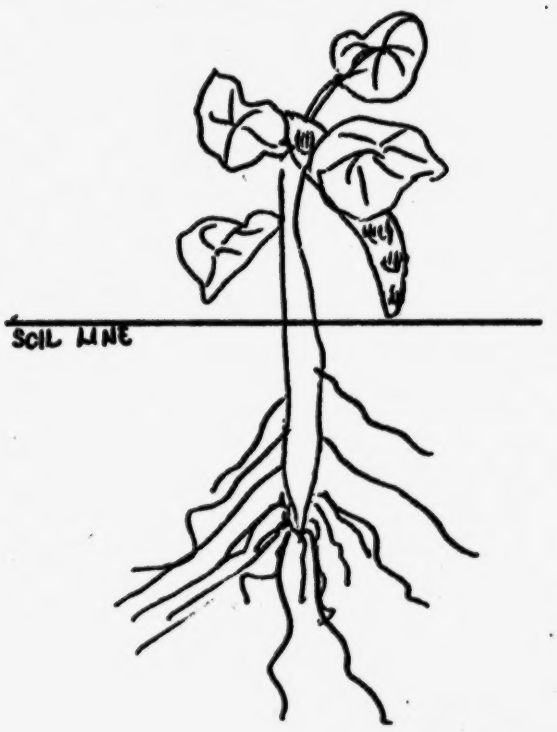
Emerging Plant
(5 day)




First True Leaves



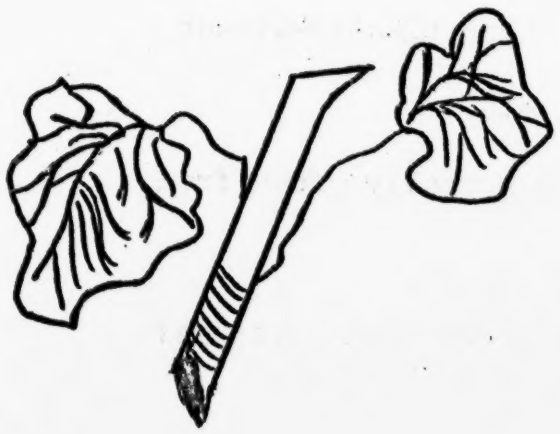

Blooming and Seedpod



Suggested arrangement:

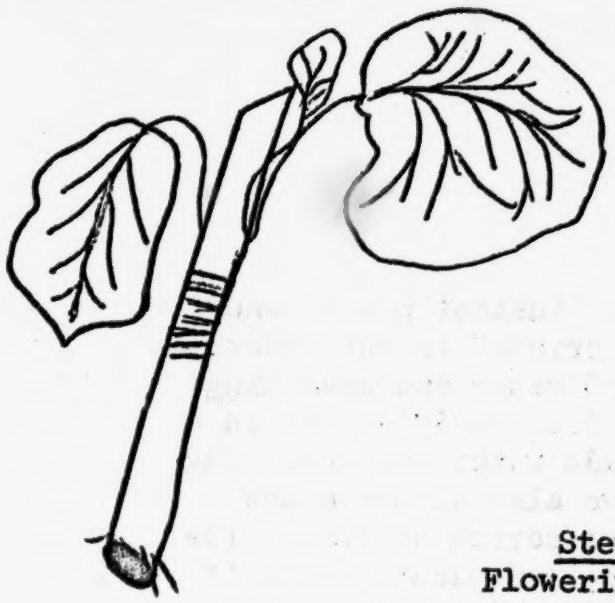
Geranium cuttings

Step 1
Freshly cut stem cutting

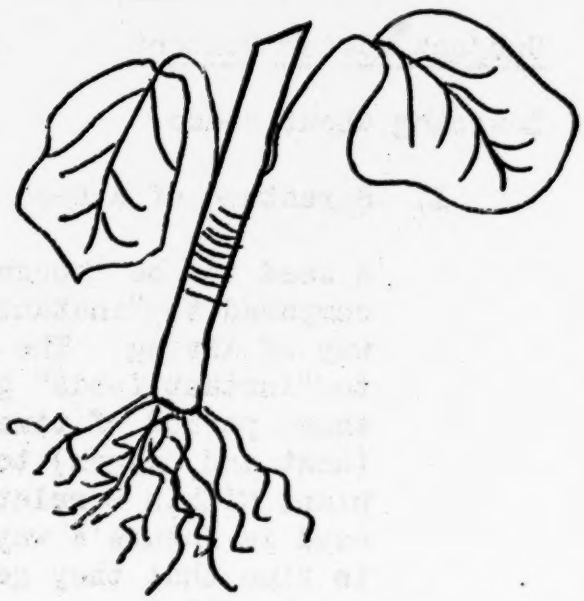


Step 2
Cutting in
rooting medium

Step 3
Calloused cutting



Step 4
Rooted cutting
(bare roots)



Step 5
Flowering plant
in pot

3. Discussion questions to be used to encourage individual participation and thought

   a. What are some of the largest seeds that you have seen?
      (Coconut, avocado, acorns, lima beans, etc.)

   b. What are some of the smallest seeds you have seen?
      (Tobacco, celery, lettuce, carrots, grass, petunia, fibrous)

   c. What plants have you seen that produce other plants without seeds?
      (Johnsongrass, iris, strawberries, etc.)

   d. What are some flowering plants which are normally grown from something besides seeds?
      (Iris, dahlia, tulips, etc.)

   e. What are some plants which are commonly grown from cuttings?
      (Coleus, geranium, African violet, chrysanthemum, carnation, etc.)

Competencies to be Developed

I. To develop in the student the ability to produce plants from seeds

## Teacher Preparation

### Subject Matter Content

Learning about seeds

1. Structure of a seed

   A seed can be thought of as an "instant plant" when compared to "instant foods or drinks" in our modern way of living. The addition of water and seasonings to "instant foods" gives us a food ready to eat in a short period of time. If we add water and seasoning (heat and oxygen) to a seed, we also secure a new plant within a relatively short period of time. The seed is nature's way of storing new plants until it is time that they germinate and produce more plants, which will in turn produce more seed.

   The examination of a large seed in the early stages of germination will reveal the presence of the many parts of a seed. Each of these parts is involved in the development of a plant.

2. Production of Seed

The production of seed is the chief activity of the flowers of plants. Many plant flowers are large and beautiful. The flowers of some plants are so small that it takes an expert to find them. In either case there are several parts which must be present for seed to be produced.

Just like automobile engines, flowers have many parts.

| Engine Parts | Flower Parts |
|---|---|
| Piston | Stamen (male part) |
| connecting rod | anther |
| piston pin | filament |
| compression rings | pollen sac |
| oil rings | pollen grains |
| Block | Pistil (female part) |
| cylinders | stigma |
| water jacket | style |
| | ovary |
| Valves | ovule |
| Crankshaft | |
| Spark plugs | Receptacle |
| Camshaft | |

Not all the parts of an internal combustion engine have been listed above and neither have all the parts of the flower. In each case, however, several important parts of both the engine and the flower have been named. As far as the flower is concerned all the parts necessary for the production of seed have been listed. Seed is produced by the flower through a rather complicated process. Briefly the following things must happen if the flower is to produce seed.

a. Pollen grains must be produced by the male part of the flower.

b. Egg cells must be produced by the female part of the flower. Reproductive cells produced by the female sex are called eggs.

c. The pollen produced by the male part of the flower must reach the female part of the flower. When this happens pollination is said to have occurred.

d. After pollination, a series of events happen which, in most cases, result in the egg changing or developing into a tiny new plant. This egg develops into a new plant in a structure called an ovule. This ovule is found in the ovary, and after a period of time matures into a seed. There are often several ovules developing into seeds containing young plants in any one ovary. Good examples of this are all the seeds in a watermelon, cucumber, or tomato. (If the teacher decides that the students could profit by a more technical treatment of the seed production process, this subject matter should be presented with a more technical vocabulary. Consult any good botany, biology, or horticulture text for this information.)

3. The activities of the various parts of the seed

When we look at a seed, the first thing we see is the seed coat. This seed coat may be made up of one or more than one layer. It can be compared to a can or fruit jar for holding and protecting food. We know that food which is not protected dries out or spoils. We have the same problem with seed. The seed coat performs the function of keeping the seed from completely drying out. It is also the container of the food supply of the new plant. We can say then that the seed coat protects the baby plant (embryo) and encloses the food storehouse of the seed.

As we look at a bean seed which has begun to germinate, we see that it has split into two parts. These two parts are called the seed leaves or cotyledons. Since there are two of these in the bean, we say that it is a dicotyledonous plant or, for short, a dicot. In the bean and other plants which have two seed leaves, these cotyledons contain the food supply which nourishes the new plant until it begins to make its own food.

If we look at a corn or grass seed which has begun to germinate, we see only one green point. Because there is only the one green point, corn and other plants like it are called monocotyledonous plants or monocots. There is no food stored in the seed leaf of a "monocot" such as corn, and it functions as the growing center or growth of the new plant. In these plants food is stored in another part of the seed called the endosperm. As the new plant emerges and begins to grow, this stored

food provides nourishment until the young plant begins to make its own food. The largest part of a monocot seed is the stored food area or endosperm. This is the part we enjoy when we eat corn on the cob.

At the other end of the emerging plant we find the primary root. This root serves two main purposes. It is like the foundation of a building because it anchors or holds the plant in the soil. This root is also the source of other roots which help to anchor the plant and take in minerals and water from the soil.

Also present in the emerging plant are the true leaves of the new plant. These true leaves are the point from which the plant will grow. In dicots, the growth bud is located between the two first true leaves of the new plant. In monocots, the growth bud is protected by the rolled sheath of the true leaf or plumule.

4. Storage of seeds

Seed are normally used within one year after they have been harvested. If they are in good condition when harvested and kept in a cool, dry place, they will be in good condition for planting. However, sometimes seed is left over after planting and is saved for another year. It is important to know what factors affect seed quality in storage and how to keep seed in good condition for another year. The following factors are important in storing seeds properly:

Damage - If the seed coat is broken, the seed is not likely to be good for planting. Seed can be damaged by rough handling or by insects, rats, mice or squirrels; consequently it must be handled and stored carefully. Small quantities of seed should be placed in clean, dry containers which have a tight lid to keep out insects. For added protection, a small quantity of 10% DDT dust can be added to each container of seed to control insects. Larger quantites of seed should be stored in rodent proof bins or barrels which can be fumigated with certain chemicals for insect control.

Moisture - The presence of too much moisture in and around seed is the most damaging factor in stored seed. We must make sure that the seeds are dry when placed in storage and that moisture is kept

from getting to the seed while it is stored. Most seeds retain the highest viability in a relative humidity of four to six per cent which is almost dry air. Some species may lose viability under conditions of low relative humidity. When dry seed are placed in air tight containers, moisture from the air cannot get to the seed and damage them.

Heat - Seed stored in a warm or hot room will not retain its capacity to germinate and develop new plants effectively as long as seed will which are stored in a cool or cold room. High temperatures cause the embryo to begin the growth process which weakens the seed. Research indicates that the best temperature for storing seed is between $0^{o}$ and $32^{o}$ Fahrenheit. Seed should be stored in a cool and dry room, basement, cellar or even in a refrigerator. If seed are too moist or wet when stored they are likely to build up more heat through fermentation or spoilage, and damage all seed stored.

Small lots of seed are best stored in airtight containers in a refrigerator. Containers should be labeled in order that the seed can be properly identified when it is needed. If possible, include the package in which the seed was purchased.

5. Germination of seed

   a. How seeds germinate

      Germination is the process by which the embryo or baby plant begins to grow resulting in another plant. Although many things happen at the same time, we can list the steps in some order as they generally happen when germination is taking place. These steps are:

      1) The seed absorbs or soaks up water.
      2) The seed coat softens and gets bigger.
      3) The seed swells and splits the seed coat.
      4) The primary root emerges through the split and grows downward to form the root.
      5) The upper part of the epicotyl emerges from the soil.
      6) The cotyledon (or cotyledons) open up above ground.

7) The true leaves (plumule) unroll or unfold exposing the growth bud and allowing the plant to begin to grow.

When the first "feeder" roots grow from the primary root and the true leaves begin to manufacture food for the plant, the germination process is over. The cotyledones or endosperm have furnished the food for the new plant until this time. They dry up and drop off and become part of the soil which supports the plant.

b. Factors affecting germination

The production of new plants from seeds is dependent upon the following factors:

1) Moisture - Sufficient moisture must be present so that the seed absorbs enough water to swell the seed and break the seed coat. This moisture also activates the food supply in the seed to begin the production of new cell growth and results in plant development.
2) Temperature - The primary influence of temperature is the effect it has on the seed absorption of moisture. Ideal temperatures vary according to the type of plant. We must follow the recommendations of those who have done experimental work and determine the best temperature for each type of plant.
3) Air or oxygen - There must be air present to provide the oxygen necessary for the energy releasing process known as respiration to occur in the living cells of the embryo. Lack of air can also cause the seed to rot before the plant can emerge.

c. Reasons for failures in germination

If the seed is good and there are proper amounts of heat, moisture and air, nearly all the seed will germinate. However, some factors are responsible for seeds not germinating. The more important factors are:

1) Damaged seed - Seeds with broken seed coats, insect or rodent damage or heat damage will not germinate properly or else will fail to germinate at all.

2) Old seed - Seeds which are more than one year old will not germinate as well as fresh seed, especially if the old seed was not stored properly.

3) Soil or media too wet - Too much water keeps air (oxygen) from moving around the seed, causing it to rot before the plant can emerge.

4) Temperatures too cold - When soil and/or air temperatures are low, the emerging plant develops slowly and uses up the stored food before it can manufacture its own food. Cold temperatures also slow down the absorption of water needed to start the germination process.

5) Hard seed - Some plants produce seed with a tough coat which will not allow moisture to enter the seed. In such cases, it is necessary to use a special process to weaken the outer seed coat. This special process is called scarification, and is used to weaken the outer seed coat so that water may be absorbed to begin the process of germination.

6) Disease - Many diseases which affect plants are caused by bacteria or fungi carried to the young plant by air, water, or insects. These pests are present on the seed itself or are present in the soil. Damping off is one of the more common diseases affecting new plants. Many of these diseases can be controlled by using various seed treatments and through sterilization of the soil or media in which the seeds are planted.

7) Drying out of soil or media - It is necessary to keep the soil or media well watered after seeds are planted. Care must be taken to keep the soil or media moist enough so that the seed have a continuous supply of moisture, but not so much as to encourage damping off or reduced aeration of the media.

8) Planting too deep - Seeds which are placed too deep in the soil or media may fail to produce a plant. These seeds will use all of their stored food and energy before reaching the surface and die before they can begin to make their own food. A good rule to follow is to plant seed no deeper than three times the smallest thickness or size of the seed. Most small seeds should be planted from 1/8" to 1/4" deep with a covering of a loose moistured holding medium.

9) Dormancy or rest period of the seed - Various treatments may be required to break the dormancy of the embryo.

6. Viability of seed

The term viable refers to the quality of being capable of germinating and growing. We need to know how many seed in a given number of seed will germinate so that we can determine how many seed to get the number of plants needed. Viability is expressed as a percentage figure. If 100 seeds are planted and only 50 of them germinate, the germination rate is 50%. In this case twice as much seed would have to be planted in order to get 100 plants as from seeds having 100% germination.

$$\text{Germination Percentage} = \frac{\text{Number of Seeds Germinated}}{\text{Number of Seeds Planted}} \times 100\%$$

We should test seed before planting if the germination percentage is not known. Fresh packets or bags of seed purchased from seed dealers will usually have the germination percentage printed on the packet or a tag. All seed which is kept over from one season to the next or seed gathered locally should be tested before planting. This testing can be done in the classroom, laboratory or at home by placing 100 seeds in a wet paper towel. Keep the paper towel moist and warm for several days. The towel can then be opened and the germinated seeds can be seen and counted. You can also send your seed to a seed-testing laboratory to have them accurately checked. Check on available laboratories and costs.

7. Reading and understanding labels on packages

Most seed dealers provide certain information about the seed being sold. Included in this information are such things as (1) germination percentage, (2) year the seed was produced or should be planted in, (3) the amount of other material present (inert material) expressed in percentage, (4) purity of the seed, and (5) whether or not weed seed are present.

Also found on packets of garden seed are basic instructions for planting the seed and how to care for the new plants. It is important to read and understand all of this information. It was put there by people who know the seed better than the student and their instructions can save him loss or trouble. Always read and follow any directions given by producers or manufacturers; they have been tested and proven.

## 8. Direct seeding

### a. Preparing seed for planting

Many seed can be planted with little or no preparation. However, to insure obtaining plants of good quality, most seeds should be treated to prevent diseases in the seedling stage. There are several commercial preparations which can be used. The directions of the manufacturers should be followed carefully. Improper use of these materials can be dangergous to students and can damage or injure the young seedlings.

Seed which have a waxy, heavy or hard seed coat may need to be treated in some way to insure better or faster germination. The most common used method is that of soaking seed in warm water or in the case of some seeds, sulfuric acid. This method aids in softening the seed coat and speeds up the water absorption to begin the germination process. Seed should be placed in hot water (120°-140°F.). The container with the seed and water should be set aside to cool and soak for 12 to 24 hours. You should use four to five times as much water as you have seed. For example, place one quart of seed in a container with four or five quarts of water. Remove the seed, drain or blot off the excess water, and plant immediately.

### b. Preparing the seedbed

A well-prepared seedbed is essential to the production of high quality plants. The seedbed must be in the right condition when it is time to plant the seed. Complete the following steps to secure the best seedbed possible.

1) Remove old plant material and trash.
2) Check the moisture by squeezing a handful of soil. If the soil forms a ball that will not break up easily, it is too wet. The ideal condition for most soils is when the soil will ball easily but break up when bounced a time or two in the hand. If the soil is too dry, it will turn up cloudy and be hard to work.
3) Spade and turn the soil to a depth of eight to ten inches. Make sure organic matter is turned under.

4) Use a rake and hoe to break up lumps in the soil so that the soil particles are no larger than the seed to be planted.
5) The use of rototiller or other mechanical equipment greatly aids in doing the steps (3) and (4) above.
6) Level the top of the soil by raking lightly.
7) Where possible, allow soil to settle for a few days before planting. Rake level again if low spots appear.

c. Planting the seed

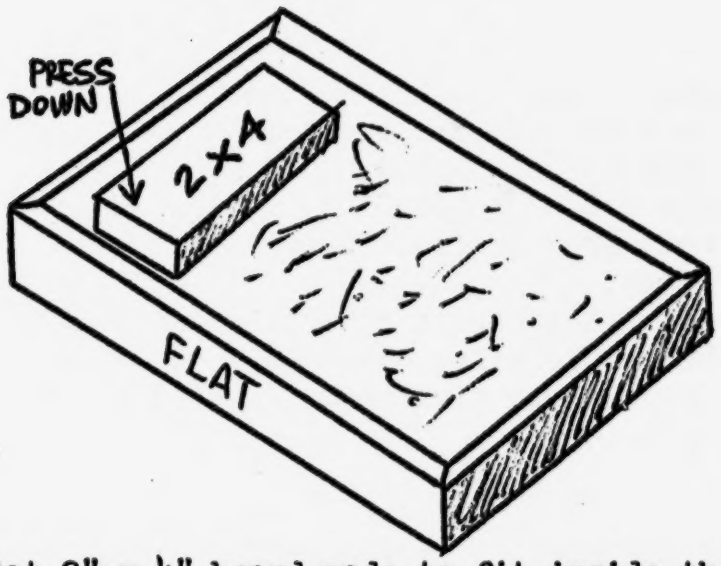
After the seedbed is prepared and ready to be planted, make rows to receive the seed. Rows should be as straight as possible so cultivation and handling of the plants are easier. This can be done by stretching a string between stakes set at the ends of the row and cutting the furrow with the corner of a hoe along the side of the string. Shallow furrows can be made by laying the hoe handle along the side of the string and pressing it lightly into the soil or by dragging the hoe handle in sweeping movements along the line.

Depth of planting is very important, especially for small seed. After the furrow has been made, care should be taken to cover the seed only 3 to 4 times as deep as the smallest diameter of the seed being planted.

Seed should be uniformly placed in the row to allow enough room for each new plant to develop properly. The size of the seeds being planted should be considered in determining the placement of seed. Smaller seed should be placed closer together than larger seed. This will aid the smaller plants to help each other to push through the soil or medium covering the seeds. Large seed should be placed individually at evenly-spaced points along the row. Follow directions on the package. When using the card or envelope the procedure is to gently vibrate the seed off the end of the card of envelope fold by tapping with the index finger at a rhythemic rate.

d. Seeding in flats

Starting plants by seeding thickly in flats is a common practice. The seed may be broadcast or planted along marked rows. The seed should be placed at a depth which allows for easy emergence of the seedling. If the seeds are broadcast, little covering is needed. Some propagators may use a layer of a sterile moisture holding material such as sphagnum moss as a seed bed to reduce the chances of damping off developing. However, care must be taken that the sphagnum moss is not soggy wet.




A flat 2" x 4" board made to fit inside the flat or a brick can be used for firming the top of the soil. In general, the smaller the seed, the less covering is needed. For example, celery seed would require less covering than either bean or corn.

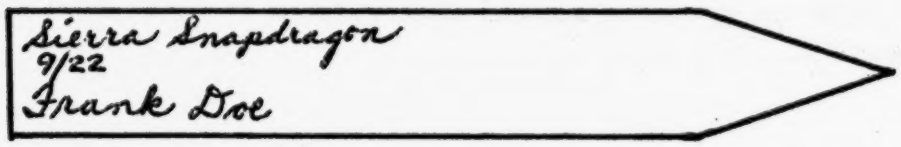
Small seeds are often hard to handle and plant. To help distribute the smallest seed, you can mix them with a small amount of sand or other inert material.

After the seed are planted in the bed and covered, water the seedbed gently. To prevent washout of fine and small seeds, use fine misting nozzles, sub-surface irrigation or place burlap bagging over the seedbed and soak the bed thoroughly. When misting nozzles or sub-surface irrigation is used to moisten the seed and media, the usual practice is to cover the flat with a piece of glass or place the entire flat in a plastic bag to converse moisture until germination occurs. After the initial watering no additional watering is usually required prior to germination.

All seeded flats should be labeled. The label should include the following information.

1) Name of plant or variety
2) Date seeded
3) Student's name
4) Special treatment, if any

Using pot labels




1) Always start entries at the blunt end of the label.
2) Allow the lower 1/3 of the label to remain free of entries for insertion into the soil of the flat (or pot). This will permit reading of the information on the label without lifting and wiping off the label.
3) The students should be taught that the seeding job is not complete until the label containing the required information pertaining to the seeding is in place in the container.

9. Care of the seedlings

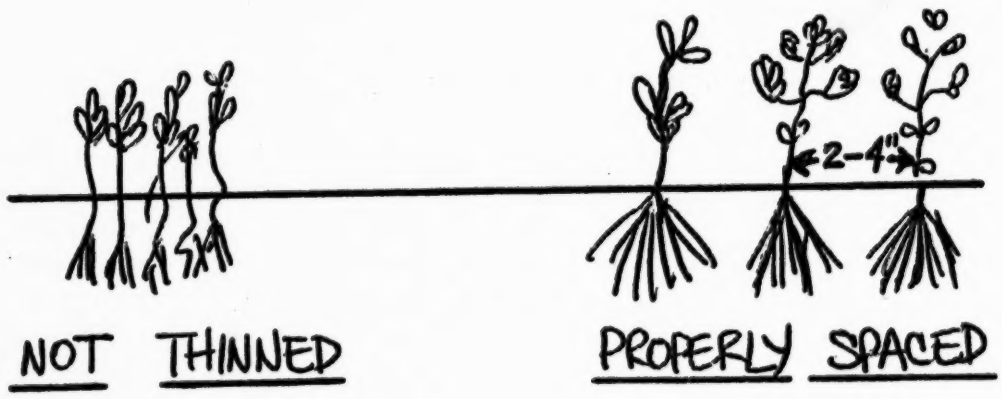
a. Watering

Following the initial watering after planting, the seedbed should be watered only enough to keep the top from drying out. Too little water may cause the seedlings to die before coming up. Too much water causes seed to rot and this can result in disease problems, such as "damping off." When the seedlings have just come up, it is necessary to water frequently until good roots are developed. As the root system develops, the time between waterings can be increased.

b. Thinning

When the seedlings are to be left in place until they are large enough for sale or use, it may be necessary to thin them out. Thinning is the removal of enough plants from the row or flat to leave proper spacing for those plants remaining. Each plant should be at least two inches from its neighbors if it is to be transplanted within two to four weeks. Where the plants are likely to grow large or rapidly before transplanting, they should be spaced further apart. Seedlings which are

removed in thinning can be placed in other rows or flats to produce additional plants rather than being wasted.




Properly spaced seedlings will produce larger and more vigorous plants. When lifted for transplanting, roots will be less tangled and not as likely to be damaged as those plants which are not thinned properly.

c. Diseases

Most diseases affecting seedlings are present either in the soil or on the seeds at planting time. The best method of controlling these diseases is prevention. Treating seeds and sterilizing (more correctly, pasteurizing) soil or media are the most effective disease preventive measures. Where sterilization of the soil is not practical, fresh soil or new plots of ground should be used for planting.

Controlling the amount and frequency of watering can help reduce the danger from many diseases in new seedlings. Watering should be done early in the morning so that plants can dry off before evening, thus helping to reduce fungus infections. Keeping the beds too wet encourages the development of bacteria and fungi.

Plants which are properly spaced and growing rapidly will not be affected by diseases as much as crowded, spindly plants. Remove weak, poor plants to prevent the spread of diseases which may be present.

With the rapid development of new techniques in disease prevention and control, many new products are on the market. Check with local dealers and companies to keep up to date in this regard.

d. Insects

Young, tender seedlings are very susceptible to insect attack and damage. Many of the diseases which affect seedlings are carried from plant to plant by insects. For these reasons it is important to recognize the presence of harmful insects and control them.

1) Chewing insects

The presence of chewing insects is the easiest to spot. The leaves and stems of young plants will become ragged or cut off if these insects are present. Insects such as the cutworm may destroy the plant completely by cutting the stem off at or below the ground level.

2) Sucking insects

Insects which suck the juices of plants are more difficult to spot until damage is further along. Insects such as thips, aphids, leafhoppers, Lygus bugs, and others can become quite numerous in a short time. Keep a continual check on young plants to know when these insects are causing damage and need to be controlled. These insects are most often found around the tender growing tip of the plant. On cool, cloudy days, they may crawl around the top of the leaves, but on sunny, warm days they are found primarily on the underside of leaves. In broad-leaved plants, the affected leaves will curl and begin to turn yellow or brown along the edges. Different insects produce widely varied symptoms and it is necessary to study each insect carefully to know what to look for.

3) Control

There are many new methods for controlling insect pests. It is important to keep up to date in this regard and students should check with representatives of chemical companies and others who

specialize in insect control. Use the recommended products in the local area and follow instructions carefully. Many of these products are dangerous to man and can harm plants if not used properly. For additional information concerning insect control see course module entitled Recognizing and Controlling Plant Pests.

e. Controlling heat and light

Both of these factors are important in new plants. They can be controlled to varying degrees when plants are grown in greenhouses, shade houses, hotbeds or coldframes. Reducing the amount of light will cause plants to grow tall or spindly. This can happen where small plants are either shaded by taller plants or are too crowded. Care should be taken to see that most young plants are exposed to good light. Where too much heat is associated with light, as in direct sun on a hot day, it is important to provide some control of the heat.

Heat is easiest to control where plants are grown in greenhouses, coldframes, and hotbeds. The most important factor in heat control is to maintain the temperature as nearly constant as possible. Big changes in temperature around growing plants cause plants to develop poorly or slowly. Moderate to low temperatures help in producing stronger, stockier plants. Different plants require different temperatures so it is important to follow planting instructions and recommendations closely.

f. Preparing the seedlings for transplanting

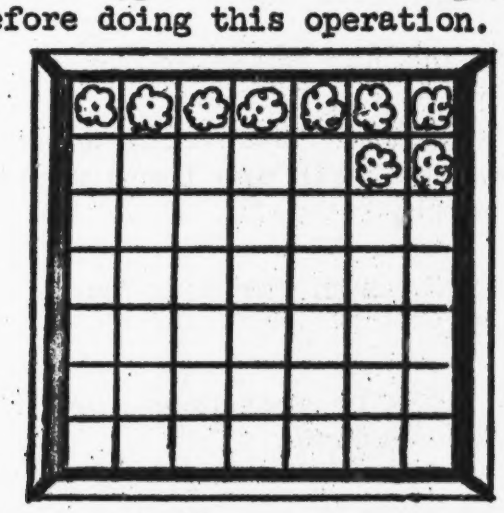
1) Hardening

Success in transplanting is highly dependent upon the care and handling of plants before moving them. The final preparation before transplanting is called "hardening off." Most plants which can be transplanted should be "hardened" before moving. Care should be taken not to "over do" this, however. This process helps the plant withstand the shock of being moved from a carefully controlled environment to the rigors of outdoor planting.

The best hardening process is to slowly change the controlled environment from the highly favorable inside conditions to those conditions found outdoors. This can be done by gradually reducing the amount of water which the plant receives and reducing the temperature in the growing area. If the plants are grown in flats or pots they can be shifted to a coldframe or lathhouse for one to two weeks.

2) Root pruning

Some plants respond well to root pruning before transplanting. This can be done in flats by drawing a sharp knife between rows of plants like cutting a cake. This process should be done about ten days before transplanting to allow the plant to recover from the shock and develop new feeder roots. Be sure that the plants are the type which will respond to root pruning before doing this operation.



3) Watering

Just before transplanting, the plants should be watered well. This will help reduce the shock of transplanting and help the soil stick to the roots. The final watering should be done far enough ahead of actual transplanting to allow the plant to take up the water and allow the soil to dry enough to prevent caking of the soil when handled.

Suggested Teaching-Learning Activities

1. Prepare a display of many kinds of seed. These can be placed in small jars or in small paper plates. Have the students identify those seeds that they are able to identify and tell what kind of plant the seed come from. Be sure to use some seeds which are used for human or pet food so that each student will have a better opportunity for success in identifying the seeds.

2. Prepare a display such as the one described for lima beans ahead of time so that it is ready for introducing the module. This display can then be used in competency number I to help the students understand the structure of a seed and the functions of its parts.

3. Use plastic models of seed and flowers to help students understand the relationship of the parts and the function of each part.

4. Have each student (or small groups of two or three students) perform the following demonstration. By varying the treatment in several demonstrations, the effect of moisture, air and temperature upon germination can be shown.

   a. Line a large mouth jar with paper towels or blotting paper.

   b. Fill the jar with peat moss, vermiculite, wood shavings or sawdust.

   c. Place some large seeds between the paper and the glass. Use beans, pumpkin, corn or any other large seed which is available.

   d. Vary the treatments (label each jar).

      1) Moisten the filling in several jars and add about one inch of water to the jar. Place some of these in a warm place.
      2) Take one of these jars and place in a refrigerator to show the effect of lower temperatures.
      3) Tightly seal one of these jars to show the effect of lack of air. (Perhaps it would be good to use a jar which had been inverted over a burning candle to exhaust the atmospheric air supply first.)

4) Fill one jar completely full of water to show effect of too much water.
5) Do not add any water to one of these jars to show the effect of no water.

e. After the seeds have had ample time to germinate, bring the jars together and have students describe what they observe. Discuss the implications of these experiments.

5. Have each student make a germination test on a sample of seed.

a. Dampen several sheets of paper towels.

b. Place a small square of peg board with 50 or 100 holes in it over the paper towels.

c. Place a small seed in each hole.

d. Remove peg board carefully.

e. Cover seed with one sheet of wet paper towel.

f. Carefully roll the towel into a loose roll and secure each end with a rubber band.

g. Place all rolls in a shallow tray or pan. Put the tray or pan in a germinator. If a germinator is not available, put the tray or pan in a warm place and cover with a lid or glass. Keep the towel moist and warm.

h. After several days, have each student check his roll and calculate the germination percentage. Discuss. See subject matter content for the formula for determining germinating percentage so that the students may be aware of how to determine the percentage if a number of seeds other than 50 or 100 is used.

6. Display several seed catalogs and packets of seed. Have students read the information on each packet of seed. Discuss. Read instructions on planting of seed or packet. Discuss. Read information about purchasing and caring for plants in the catalogs. Discuss.

7. Display samples of seed which have been treated with various commercial seed treatments. Compare with untreated seed. Discuss. Caution: MOST OF THESE

TREATMENTS ARE POISONOUS. KEEP THE TREATED SEEDS IN CLOSED JARS. DO NOT LET STUDENTS HANDLE EXCEPT UNDER SUPERVISION. DISCUSS SAFETY PROCEDURES. READ AND DISCUSS WARNINGS ON PACKAGES.

8. Take students on a field trip to see both well-prepared and poorly prepared seedbeds. This can be shown in a small garden plot or in the greenhouse.

9. Have students prepare a seedbed or a flat, seed or plant the desired crop, and care for the resulting seedlings. Each step should be a learning process under the supervision of the teacher. Rather inexpensive, quick germinating seed, such as cabbage or marigold are very good to use for student practice in seeding flats. Grow the seedlings to transplanting size and distribute them to the class members.

10. Show displays of insect and disease damage. Discuss.

11. The teacher should obtain the flowers of several different plants and point out the various parts connected with the production of seed. The tulip bloom, if available, works very well for this. The parts should be named and an explanation given as to the process by which seeds are produced. It would be well to open ovaries in various stages of maturity to expose the ovules at various stages of development.

12. If microscopes are available, interest can be developed by a study of pollen. Give attention to the enormous quantity of pollen which one flower can produce and the size and shape of the various pollen grains.

13. The "electric bee" for pollinating greenhouse tomatoes could be demonstrated and discussed.

## Suggested Instructional Materials and References

Instructional materials

1. Packets of seeds
2. Seed catalogs
3. Paper towels
4. Flat pan and cover

5. Large mouth glass jars
6. Seed sampler
7. Plastic model of flower and seed
8. Flowers of various plants. (tulip, snapdragon)
9. "Electric bee" or pollinator
10. Flats
11. State seed laws and certification regulations
12. 1" x 2" x 8' boards
13. Scrap pieces of 2" x 4" or bricks
14. Homemade row markers

References

1. Christopher, E. P. Introductory Horticulture, pp. 107-118; 158-159.
2. Hartman, Hudson T. and Kester, Dale E. Plant Propagation: Principles and Practices, pp. 41-155.
3. Mahlstede and Haber, Plant Propagation, pp. 45-156.
4. Moon, Truman J., et al. Modern Biology, pp. 116-213.
5. A Guide to Elementary School Gardening in Hawaii, Hawaii Department of Public Instruction, pp. 37-47.

## II. To develop in the student the ability to produce plants from cuttings

### Introduction

There are many books and other publications which cover the production of plants from cuttings. It is recommended that the teacher acquire one or more of these to use as a guide and to supplement material provided in this section. The material presented here should help the teacher plan his work in an organized manner. The teacher must make every effort to present the material so that it is easily understood by the students. Many technical terms can

be explained in everyday language without losing too much of their meaning. The teacher should use demonstrations and illustrations at every opportunity to help reinforce the learning process.

## Teacher Preparation

### Subject Matter Content

#### Learning about cuttings

1. Importance of cuttings

   Producing plants from cuttings is often cheaper and faster than producing them from seed, by budding or by grafting. The use of cuttings also helps maintain the characteristics of the original plant. Many types and varieties of plants will not produce the same quality or type of plant from seed and must be reproduced by cuttings, budding, or grafting.

   Commercial plant producers use cuttings to secure large numbers of plants faster than securing the same plants from seeds. Cuttings are also used because they are easier and simpler to make than various budding or grafting operations.

2. Types of cuttings

   Cuttings are classified and named according to the part of the plant from which they come.

   Stem cuttings

   These are the most important and more commonly used types of cuttings than the others listed here. They are made by cutting a segment or piece of a growing limb or shoot from the parent plant. These cuttings are further classified or named by the type of wood or growth period from which the cuttings are made.

   a. Hardwood cuttings - These are usually made in the winter months (or dormant stage) from plants or trees which shed their leaves. Plants propagated by hardwood cuttings include Junipers and Yews.

b. Semi-hardwood cuttings - These are usually made from evergreen plants and are cut from newer growth on the plant after it has finished the rapid summer growth. Plants propagated by semi-hardwood cuttings include euonymus, evergreen azaleas, and holly.

c. Softwood cuttings - These are made from new growth in spring or early summer while that part of the plant is growing rapidly. Plants propagated by softwood cuttings include pyracantha, magnolea, and spirea.

d. Herbaceous cuttings - These are made from plant materials which are soft, rapidly growing, and relatively high in water content. Plants propagated by herbaceous cuttings include coleus, chrysanthemum, geranium, and carnation.

Leaf cuttings

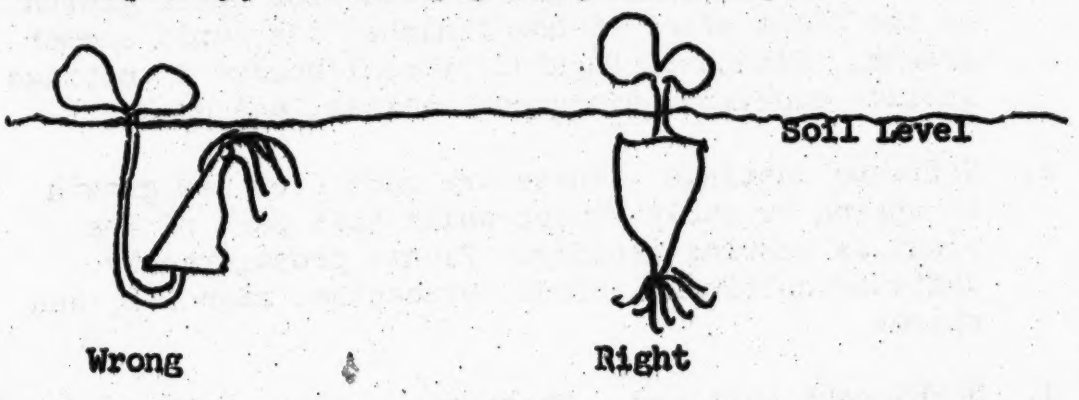
There are some plants which can be reproduced by using a leaf or portions of a leaf to produce a new plant. Most of these are house plants and are interesting to use in demonstrations. Plants propagated by leaf cuttings include Sansevieria, Begonia rex, Saintpaulia (African violet) and Peperonia.

This type of cutting consists of one or more leaves attached to a short piece of stem. There is a well-developed bud next to the point at which the leaf is attached to the stem. The plant material should be healthy, actively growing and the buds well developed. The ideal time for making these cuttings is late summer. Plants propagated by leaf bud cuttings include Camellia and rhododendron.

Root cuttings

Plants which sucker or send up new plants from roots are ideally suited for this type of cutting. This is a very simple type of cutting to make. Placing the root section in the medium in the same relative position as it was removed from the parent plant requires some

attention. Plants propagated by root cuttings include red raspberry, flowering quince, and holly.




3. Factors which affect success in making and rooting cuttings

Time when cuttings are made

Plants can be propagated by various types of cuttings throughout the year. However, practically all plants have one or more periods during the year in which cuttings from them will root better than those taken at other times. There are few plants which will not root well unless cuttings are taken at specific times. There are many reference materials which will help determine the best time for making cuttings of most plant materials. Follow these recommendations carefully to insure greater success in rooting of cuttings.

Age of the parent plant

A greater degree of success in rooting cuttings can be achieved by taking the first laterals produced after the first flush of growth. It is important to follow the recommendations for the type of material being rooted.

Media

There are only a few plants which need a special media in which to root. Clean sand is most commonly used because it can be sterilized and contains little material present which affects plant growth in any way. Selection of media should be based on recommendations for the type of material being rooted.

Treatment of cutting

a. Wounding

Many types of plant material will not root well without wounding the base of the cutting. This can be done by cutting through the outer layers with a sharp knife or razor blade. On larger material, several cuts should be made.

b. Root promoting materials

Greater success in rooting can be achieved by using one of the root promoting materials that are commercially available. Many plants which are difficult to root can be readily rooted by treating with one of these materials. Plant material which roots better with wounding will root even better where these materials are applied after wounding.

Environmental conditions

The proper balance of heat, light, and humidity are important for success in rooting. The loss of water from cuttings is a critical factor in getting them to root well. Many plants will root only if kept under high humidity conditions. The amount of moisture in the air (humidity) is affected by temperature. The warmer the air the more moisture (water) it will hold. For this reason, the temperature should be kept between 70° and 80°F. during the day and between 60° and 70°F. at night.

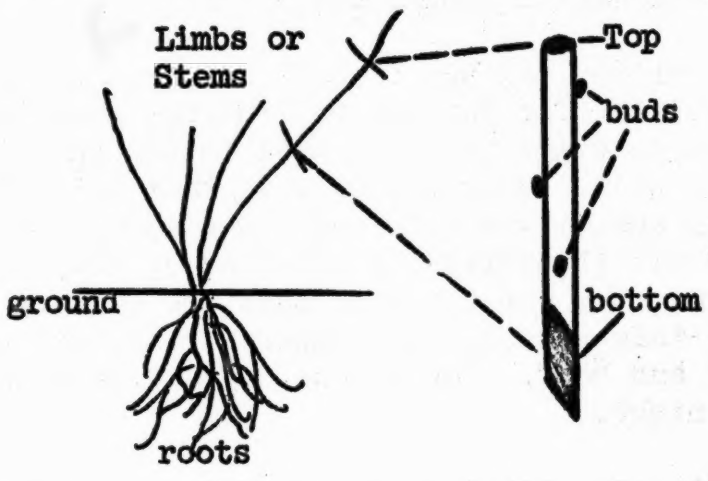
Additional moisture can be placed in the air through a misting system. Where this is not practical the plant material can be placed in a bed or flat which can be covered with glass or plastic to keep the moisture from evaporating into the surrounding air.

Cuttings with leaves left on or which have developing leaves should be exposed to good light. However, some plant materials root better when held in darkness for a time. All of the factors mentioned have been the subject of much investigation and study and many recommendations for improvement are available. For best results follow these recommendations closely.

4. Making cuttings of various types

a. Stem cuttings - Procedure

1) Select healthy, vigorous parent plants.
2) Make cuttings at recommended time of year or stage of growth.
3) Cuttings should be from three to eight inches long with three or more buds or leaves. Some hardwood cuttings such as Solix can be up to 15 inches long.
4) Use sharp knife to prevent crushing of stem. Woody materials can be cut with shears.
5) Cut stem pieces flat on top and slanting on the bottom. This will help in placing the cuttings in the media in the right position for normal growth.
6) Some plants root better where the cutting includes some older wood. The "heel" or "mallet" cuttings provides for this.



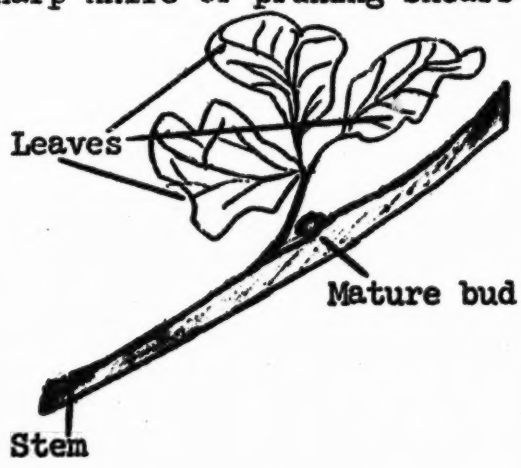

b. Leaf cuttings - Procedure

1) Select healthy vigorous parent plant
2) Remove a large, well-matured leaf
3) Follow recommendations for wounding or cutting for each type of plant. Refer to reference material.

c. Leaf-bud cuttings - Procedure

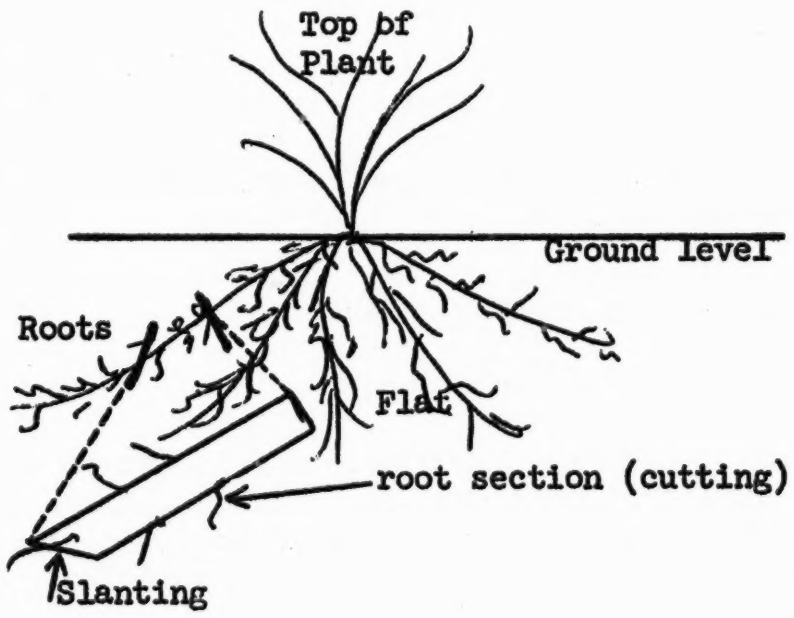
1) Select healthy, vigorous parent plant
2) Select stems with healthy, actively growing leaves having well-developed buds.
3) Cut a 2-3 inch section of stem with a mature bud and leaves.

4) Use a sharp knife or pruning shears




d. Root cuttings - Procedure

1) Select healthy, vigorous parent plant
2) Dig soil or media from around the roots
3) Cut root from parent plant
4) Divide root into sections of two to six inches in length
5) Cut the top end of root cutting flat and the bottom end of cutting on the slant. This will guide the placement of the cutting in a normal position in the rooting media.



5. Rooting and cuttings

Preparation of Cutting

Callusing

Hardwood cuttings should be allowed to form a callus before placing them in the rooting bed or media. This can be done by placing them in a box of moist wood shavings or peat moss for several weeks before planting. The cutting should not be allowed to dry out during this period. Many types of cuttings do not need this step, but it does improve the formation of roots on most hardwood cuttings.

Wounding

Some types of plants such as species of Juniper do not root well unless the base of the cuttings are wounded. This is particularly true of many of the evergreens. Wounding can be done by stripping the lower side branches from the stem. In some plants it is necessary to remove segments of the bark at the base or make several cuts through the bark at the base of the cutting.

Treatment with root inducing materials

Plants which are difficult to root in cuttings should have these cuttings treated with rooting hormones. Several of these are available commerically. Follow the instruction of the manufacturer carefully to secure the proper results.

6. Placing in the rooting media

Preparation of Media or Bed

The rooting bed or frame should be prepared several days before placing the cuttings. The material should be deep enough so that the cuttings can be inserted up to one half their total length and still have the bottom end at least an inch from the bottom of the bed. Further discussion of the types and preparation of media can be found in competency number IV of Module Number 5.

Procedure

a. Lay a flat board on the bed. This board should be the same width as the bed and from two to three inches wide.

b. Use a thick-bladed flat knife or trowel to make a deep cut in the media along one edge of the board.

c. Place the cuttings in the cut with at least one half of their length below the top of the cut.

d. Space the cuttings so that the leaves just touch their neighbors or allow just a small amount of room between cuttings with no leaves.

e. Press the flat board against the open cut so the media is against the cuttings.

f. Move the board to the other side of the row of openings and repeat the operations.

g. After all cuttings are in place, the bed should be carefully flooded to settle the media around the cuttings.

h. Future waterings should be very light mistings.

7. Care of the cuttings during rooting

This area is covered in competency number V in the module entitled Growing Horticultural Plants, Module Number 4.

Use the subject matter content in this competency to instruct the students in controlling moisture, temperature, and light.

Further reference should be made to the literature in this area to determine special instruction and recommendations for different kinds of cuttings.

8. Preparing the cuttings for transplanting

Refer to competency number VI of the module Growing Horticultural Plants. The most important part of this competency is the section devoted to "hardening." The student must understand the reasons for this process and know how to do it. Further reference should be

made to the literature in this area to determine special instructions and recommendations for properly preparing cuttings for transplanting.

Suggested Teaching-Learning Activities

1. Use the suggested arrangement developed for introducing the module to demonstrate steps in propagating plants by cuttings.

2. Illustrate the type of cuttings by both drawings and demonstrations of how each cutting is made.

3. Have each student make a stem cutting of a plant which is easily rooted, such as Coleus, and root it to take home for a house plant.

4. Have each student prepare several cuttings. Treat most of these with rooting hormones. Place these cuttings in a rooting bed or frame and have students care for them. When sufficient time has elapsed, evaluate each student's work and discuss probable causes of failures or poor rooting. Compare the difference between cuttings treated with rooting hormones and cuttings that are not treated. Demonstrate the proper ways for making cuttings to help reduce the failures noted.

5. Have students reproduce plants for sale or other uses by making and rooting cuttings of the appropriate type.

Suggested Instructional Materials and References

Instructional materials

1. Plant materials for cuttings
2. Rooting hormones
3. Pots or flats
4. Rooting media or potting soil
5. Hand shears and/or knife
6. Garden hose

7. A greenhouse bench with a misting system would be highly desirable for rooting the various cuttings.

References

1. Christopher, E. P. Introductory Horticulture, pp. 119-124.

2. Hartment, Hudson T. and Kester, Dale E. Plant Propagation: Principles and Practices, pp. 225-265.

3. Mahlstede, John P. and Haber, Ernest. Plant Propagation, pp. 191-228.

4. Wells, James S. Plant Propagation Practices, pp. 76-134.

III. To develop in the student the ability to produce plants by layerage

## Teacher Preparation

### Subject Matter Content

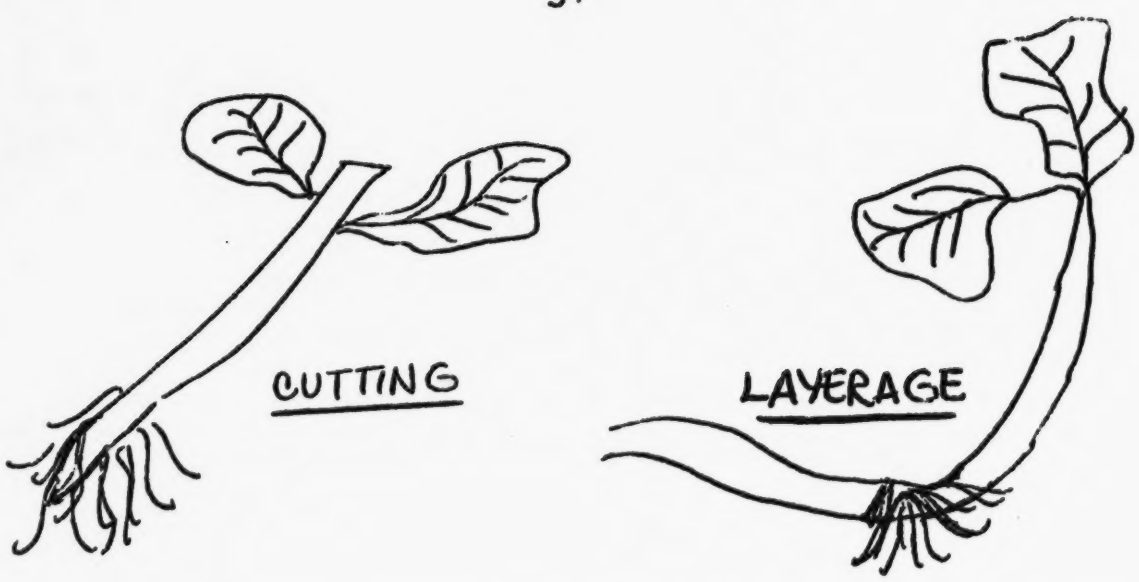
#### Knowing about Layerage

Importance of layerage

The production of a new plant by layerage is a relatively dependable method of inducing rooting. It is commonly used to propagate plants which are difficult either to root by cuttage or to reproduce by graftage. It is also a excellent method for propagating plants which do not come true from seed. In some cases, a layer plant can be produced in a shorter time than by other methods of propagation. However, layerage is a relatively expensive method and does not lend itself to the production of large numbers of plants. Propagation by cuttage or graftage is preferred where these means are successful in producing new plants.

Difference of layerage from cuttage

In propagating plants by cuttings, portions of the stems of the parent plant are cut and rooted separately. In layerage a portion of the stem is rooted before removing that section of the stem from the parent plant.

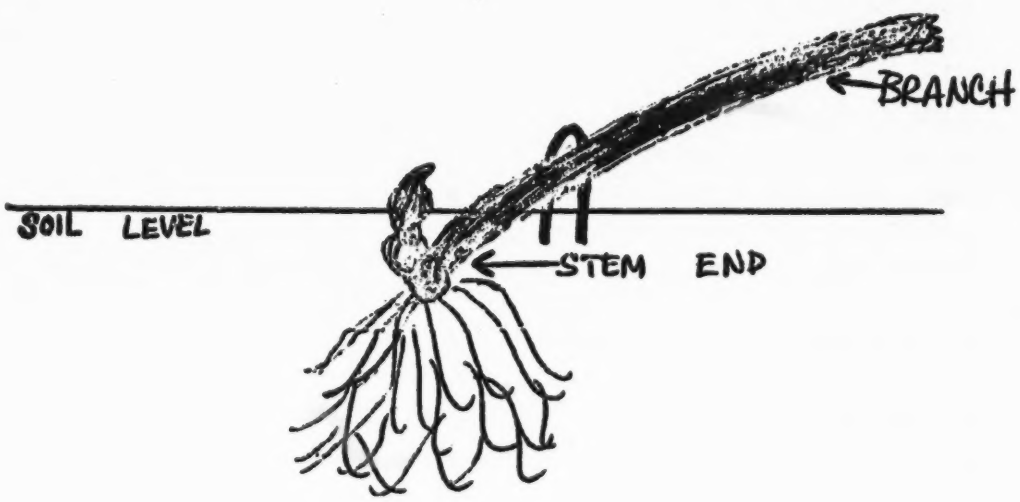



In the layerage process, the parent plant supports the new plant until it is well rooted. In cuttage it is necessary to keep the cuttings under highly favorable conditions to secure rooting.

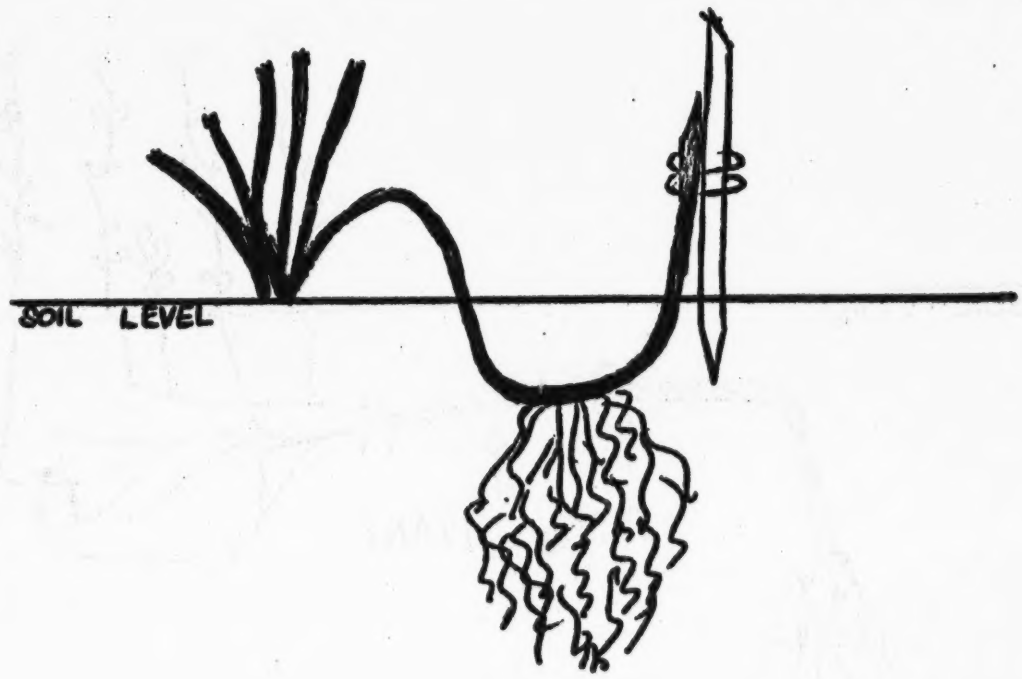
Kinds of layerage

Ground layerage: Rooting of a portion of a stem still attached to the parent plant, in the soil surrounding the parent plant is known as ground layering. The various types of ground layerage are

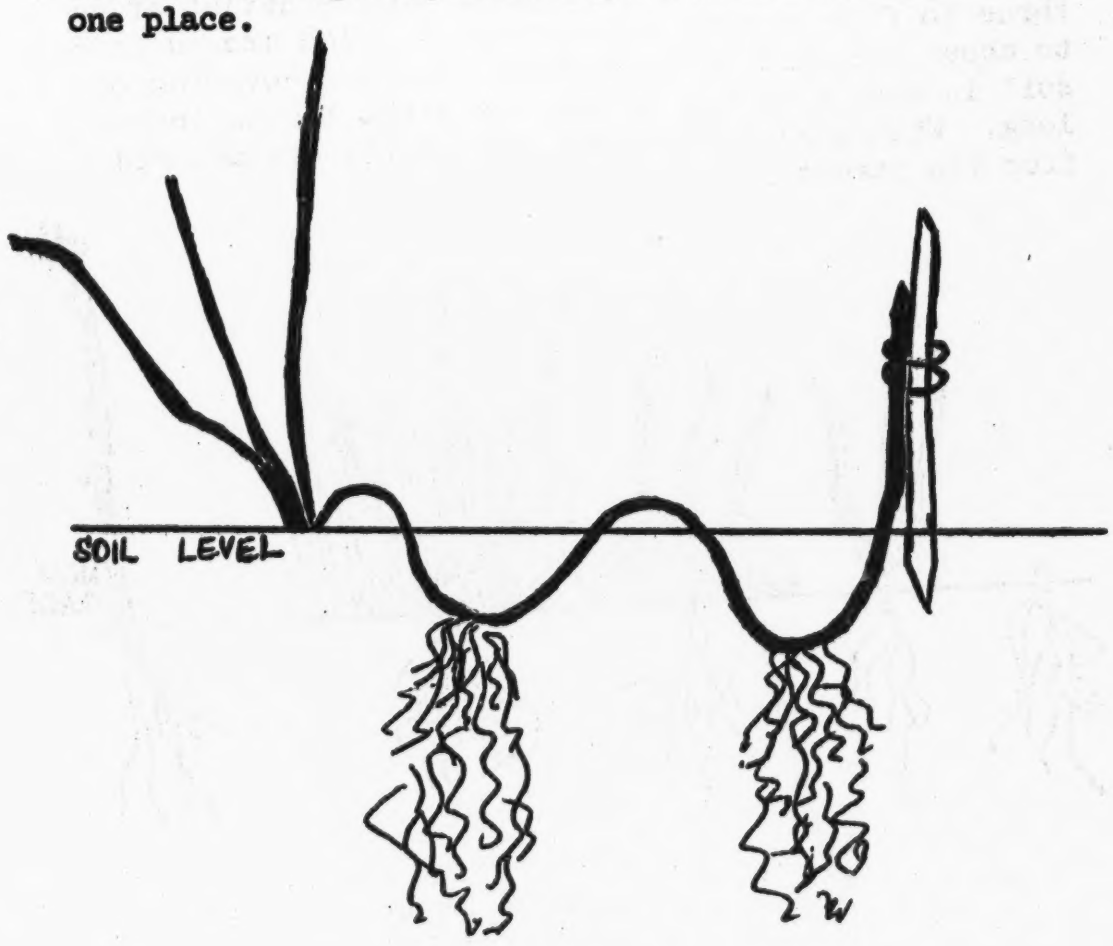
1. Tip layerage - where the tip of a branch is placed in one to two inches of soil and allowed to root



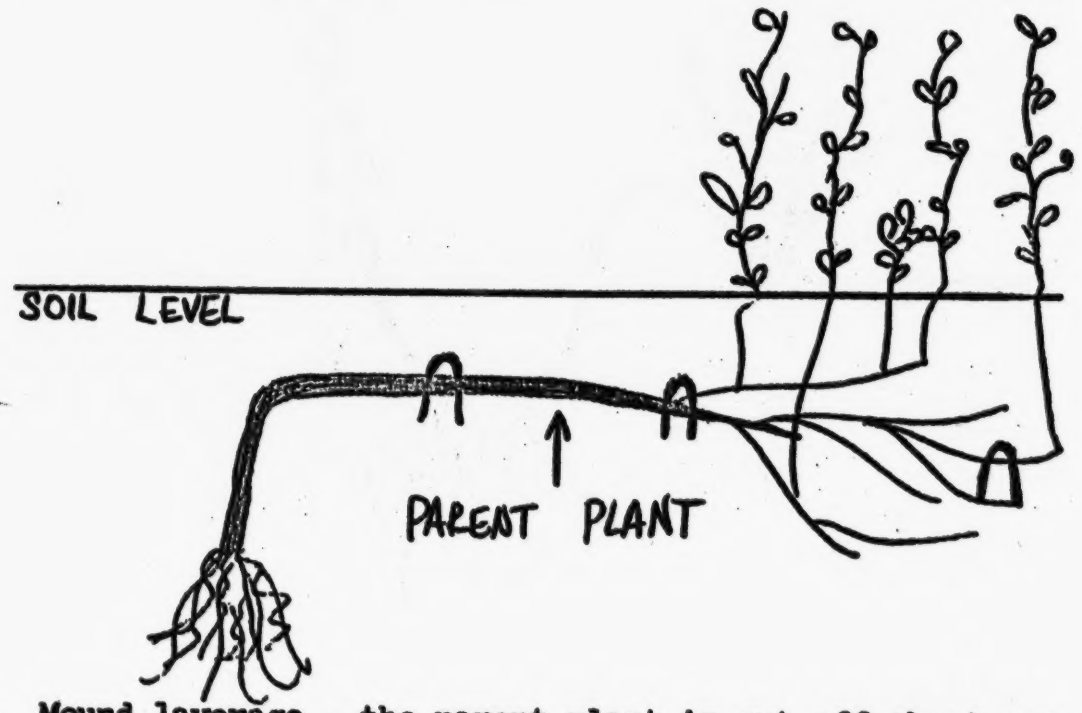
2. Simple layerage - a portion of the stem is buried from three to six inches deep and allowed to root.



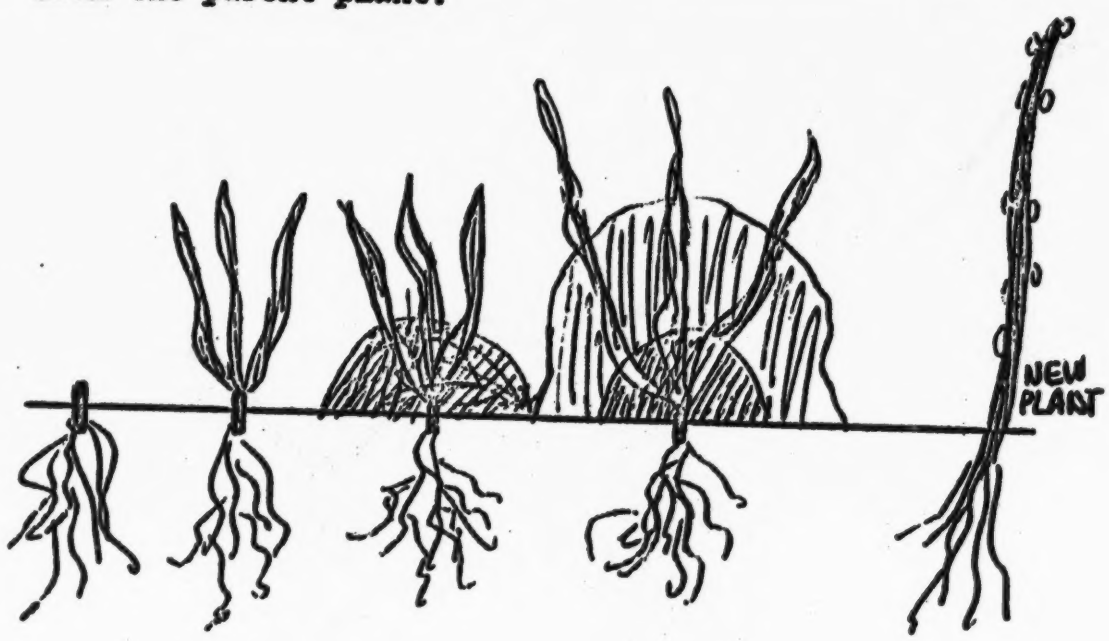

3. Compound or serpentine layerage - a stem is alternately covered and exposed, allowing it to root in more than one place.



4. Trench layerage - the entire plant is bent over and covered, allowing for the production of several new plants from one parent plant.




5. Mound layerage - the parent plant is cut off about one inch above the ground level. New shoots develop from the stub. After these have grown to the height of three to five inches, loose soil is piled around them to about one half their length. Another covering of soil is made when the shoots are eight to ten inches long. When well rooted, the new plants are severed from the parent plant.



Air layerage: Where the stem is too large or too far from the ground to use ground layering, air layerage is more practical. In this process, a rooting medium is placed around a previously prepared point on the limb and kept in place until roots develop. The basic steps in the procedure are

1. Select parent branch or stem
2. Wound or girdle the stem six to twelve inches from the tip at least
3. Apply rooting compound to the wound
4. Place two handfuls of slightly moistened sphagnum moss around the wounded point on the stem.
5. Wrap the ball of moss with a sheet of plastic film and secure both ends with tape.
6. When roots are well established, remove the rooted tip from the parent plant and pot.

AIR LAYERAGE

Making a ground layer: The ideal time for layering is at the beginning of the growing season. Stems layered at this time will usually be well rooted by fall. The new plants can then be removed in the fall or the next spring before growth begins. The best stem or wood to use is a healthy, one year old shoot which is flexible. The procedure to follow in making a ground layer is:

1. Select parent plant.
2. Select one year old, dormant stem.

3. Wound or sharply bend the stem at a point six to twelve inches from the tip.

4. Use a peg, bent wire, or stone to hold the layer in place in the soil.

5. Tie the tip loosely to a stake to hold it in an upright position.

6. Cover the layer with three to six inches of soil. It is good to add peat moss or other organic material to the soil to help keep it loose and hold more moisture.

7. When well-rooted, remove from parent plant.

Care of new plants

Plants produced by layerage normally have more vegetative growth than what their new roots can support adequately. It is necessary to further develop these roots before planting in a permanent place. In some instances, it is necessary to prune the top of the new plant to reduce the top to a size in keeping with the roots available. When the new plant is removed from the parent plant, it should be handled in the same way as a rooted cutting. Follow the suggestions and directions for specific plants found in the reference materials.

Layered plants should be hardened before transplanting. Again this can be done by the same method applied to cuttings. Some types of plants can often be moved directly from the layering situation to a permanent location.

Suggested Teaching-Learning Activities

1. Take students on field trip to view plants being produced by layering. It may be possible to find native plants which are reproducing naturally by tip layering. (Brambles such as blackberries, raspberries, etc.)

2. Where suitable plants are available, give demonstrations of the various types of layering.

3. Prepare well in advance, an air layer on an ornamental rubber plant or croton. Demonstrate this procedure in the classroom or greenhouse and have each student prepare an air layer using tomato plants. Results may be expected in five to ten days with these plants.

4. Have students pot and care for new plants produced by layerage.

5. Have students produce plants for sale or use by the layerage method where practical in the community.

Suggested Instructional Materials and References

Instructional materials

1. Plant materials
2. Plastic film or sheeting
3. Rubber bands or twist ties
4. Wire clips or wood stakes
5. Rooting hormones
6. Peat moss or spahgnum moss

References

1. Christopher, E. P. Introductory Horticulture, pp. 124-127.
2. Hartman, Hudson T., et.al. Plant Propagation: Principles and Practices, pp. 399-421.
3. Mahlstede, John P. and Ernest S. Haber. Plant Propagation, pp. 182-190.
4. Wells, James S. Plant Propagation Practices, pp. 155-164.

IV. To develop in the student an understanding of budding and grafting as methods of plant propagation

Introduction

In planning this competency, the teacher should limit the introduction to acquainting the students with the procedures for doing budding and grafting. This competency is not designed for the "doing" level. If the teacher can identify certain students who show interest and ability in this area, further instruction can be given on an individual basis. To develop proficiency in this competency, the student should be placed in occupational training with a competent supervisor.

## Teacher Preparation

### Subject Matter Content

#### Learning about budding

Budding is a form of grafting which utilizes only one bud and a small piece of bark. It is often referred to as "bed grafting." Budding is done primarily during the spring and summer months while the plant is in active growth. However, chip budding can be done during periods when the plant is dormant.

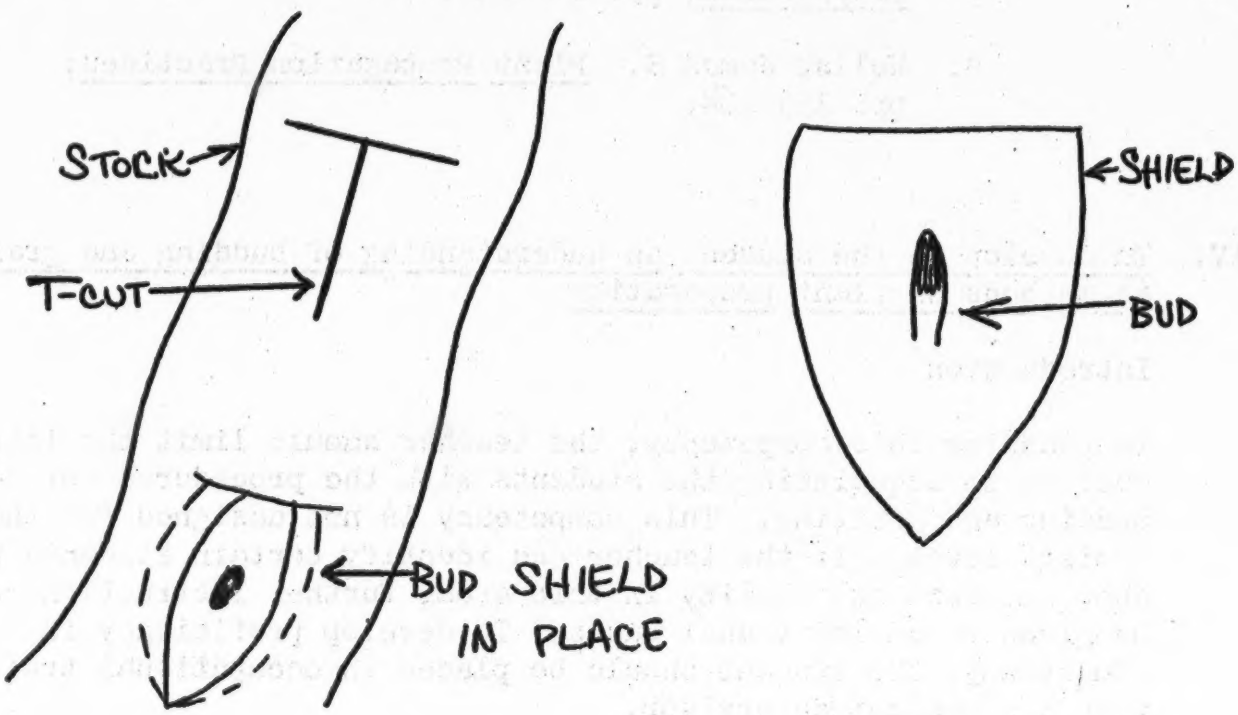
#### Methods of budding

T-budding

T-budding is the most common method of budding plants. It is also called shield budding. A shield-shaped bud patch is taken from the bud-wood. This shield is slipped into the "T" cut on the stock and the wound is wrapped to keep excessive moisture out and to hold the bud in place while the union is taking place.

In areas where considerable rainfall is likely to occur during the budding season, the "T" bud should be inverted. This will allow the wound to drain or not accumulate moisture which can delay healing. The inverted "T" should also be used on plants which are likely to bleed heavily.

Care should be taken to reverse the cutting of the bud shield. This will keep the bud pointing in the proper direction to secure normal, rapid growth.




"T"- BUD

Patch budding

Although there are many variations of this type of budding, they are all basically the same. A rectangular patch of bark is removed from the plant to be budded. Patch budders are available commercially or the student may make them.

This patch is then replaced with another of similar size and shape, containing a bud of the variety to be propagated. Some of the variations of patch budding are

1. I-bud - The bark on the stock is split in the shape of an "I" and the patch is inserted beneath the two flaps.

2. Flute bud - All but about 1/8 inch of a ring of bark is removed and a similar patch is placed on the stock.

3. Ring bud - A full ring of bark is removed from the stock and a bud patch of the same size and shape replaces it.

Patch budding is slower and more difficult to perform than T-budding. It is primarily useful on varieties which have thick bark, or in other cases where a T-bud will not fit tightly. Some precautions which should be taken in patch budding are:

1. The size of the budstick should be about the same as the stock to insure a tighter fit.

2. The bark on both the stock and the budwood must slip easily.

3. The patch should be removed from the budstick by pushing it sideways so as to retain the core of the bud.

4. The bud patch should be the same size and shape as the patch removed from the stock.

5. Care should be taken to have the patch in close contact with the stock and fitted closely to the edges of the cuts on the stock.

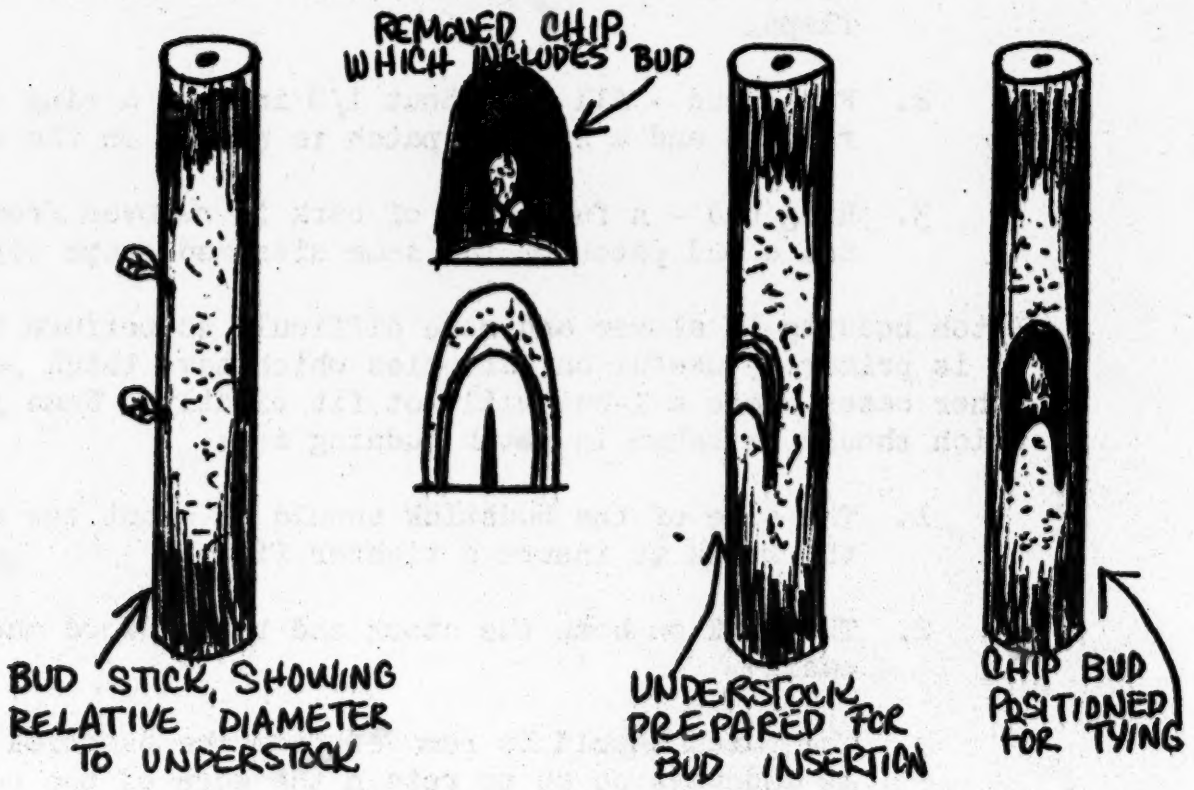
6. When tying the patch, leave the bud exposed and keep the patch from buckling. On a fast growing stock, cut the tie after ten days, but do not remove the tie materials.

Chip budding

Chip budding can be done during periods of the year when the bark is not slipping and when other types of budding do not work well. It is somewhat slower and not as simple as T-budding. The procedures and precautions which should be followed in chip buddding are

1. A chip of bark is removed from a smooth area between the nodes on the stock.

2. A similar chip, containing one bud, is taken from the budwood and placed in the cut on the stock. Care should be taken to make both cuts as nearly alike as possible to insure a good fit of the bud chip.


REMOVED CHIP, WHICH INCLUDES BUD
BUD STICK, SHOWING RELATIVE DIAMETER TO UNDERSTOCK
UNDERSTOCK PREPARED FOR BUD INSERTION
CHIP BUD POSITIONED FOR TYING

3. After the bud chip is inserted in the stock, seal the exposed edges with grafting wax or secure with nurseryman's adhesive tape to keep the union from drying out.

4. Be sure that the cambium layers of the chip contact those on the stock.

5. Plant materials should be fairly small, usually between one half to one inch in diameter.

### Knowing about grafting

Grafting is the process of joining the parts of plants together in such a way that they will unite and grow as one plant. As referred to here, it differs from budding in that the budwood or scion has more than one bud when attached to the stock. There are many variations of grafting and the ones which are commonly used in a local area should be stressed. Many good references exist which outline the procedures and precautions. Some of these references are listed here.

Success or failure in grafting is dependent upon the following items:

1. How well the <u>scion</u> is fitted to the <u>stock</u>

2. Whether the plant materials being used can adjust to one another or not

3. The amount of contact between the cambium layers of the scion and stock

4. The care and maintenance of the graft after completion. This serves to prevent the injury from drying out and preventing the entrance of decay-producing organisms.

Since grafting is a complex procedure and considerable skill is needed, the teacher should be cautious in allowing students to work on valuable plants. After demonstrating several procedures, the teacher might allow the students to produce a graft on expendable materials. Any further study and discussion on grafting should be based on good reference materials.

### <u>Suggested Teaching-Learning Activities</u>

1. Take students on a field trip to see budding and grafting being done commercially.

2. Use large charts or overhead projection pictures to show the step-by-step procedure of performing budding and grafting operations.

3. Demonstrate several methods of budding and grafting and discuss the advantages and disadvantages of each.

4. Show students how to wrap, tie, cover and care for buds and grafts. Show how to check for good "take" on buds and grafts and discuss the care of new buds and grafts.

5. Where the students understand the procedures and desire to try their hand at budding and grafting, use sections of limbs and budwood which can be brought into the laboratory as practice materials. Members of the Solanaseous family such as potato, tomato, and jimson weed are quite useful herbaceous dicots for student practice in grafting. See Hartman and Kester, pp. 171.

6. Where the teacher can identify individual students who show strong ability and interest, he should place these individuals in on-the-job situations under supervision.

## Suggested Instructional Materials and References

### Instructional materials

1. Sample plant materials

2. Examples of various techniques of budding and grafting

3. Budding knives

4. Tie materials such as rubber bands and raffia

5. Budding and grafting wax

### References

1. Christopher, E. P. Introductory Horticulture, pp. 128-140.

2. Hartman and Kester. Plant Propagation: Principles and Practices, pp. 373-398.

3. Mahlstede, John P. Plant Propagation, pp. 239-275.

4. Wells, James S. Plant Propagation Practices, pp. 135-154.

V. To develop in the student the ability to build containers and equipment required for plant propagation

## Teacher Preparation

### Subject Matter Content

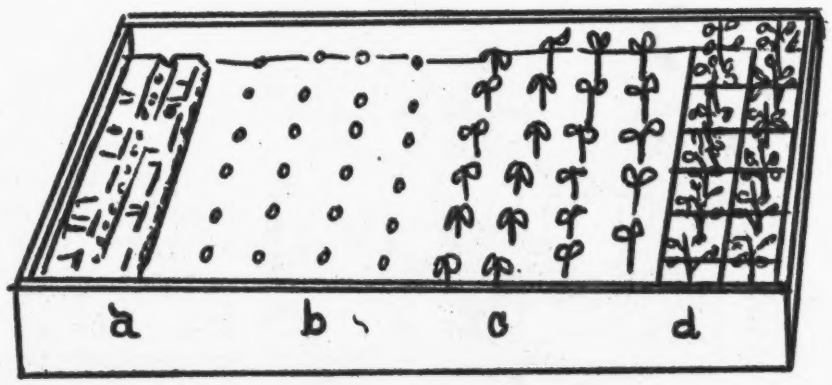
The areas to be studied in this competency are the construction of: (1) flats (2) planting boards (dibble boards) and (3) row markers.

### Flats

Plant containers are of two major kinds: (1) plant containers which are used to raise plants in groups, and (2) plant containers used to raise plants individually. The main type of group container is called a flat, usually constructed from wood.

Most growers use flats measuring 12 x 24 x 3 inches, although the width may be from 6 to 24 inches, and length from 18 to 36 inches. Care must be taken not to build flats too large as they will be very heavy when filled with soil as flats are usually moved from time to time, this is an important consideration.

Figure 1




Shown above is an example of a flat commonly used to start plants in greenhouse or cold frame. At "a", furrows have been opened and seed sown. At "b", a planting board with evenly spaced pegs has been used to start holes for seedlings. At "c", the seedlings have been planted, and at "d", a knife has been used to cut roots between seedlings to produce more compact root systems.

Plant containers have two uses: (1) the growing of plants to full maturity, and (2) the growing of plants for transplanting to the field, garden, greenhouse bench, or bed.

Flats help to keep crop growing operations on schedule and make better use of the greenhouse, hotbed, and cold frame space.

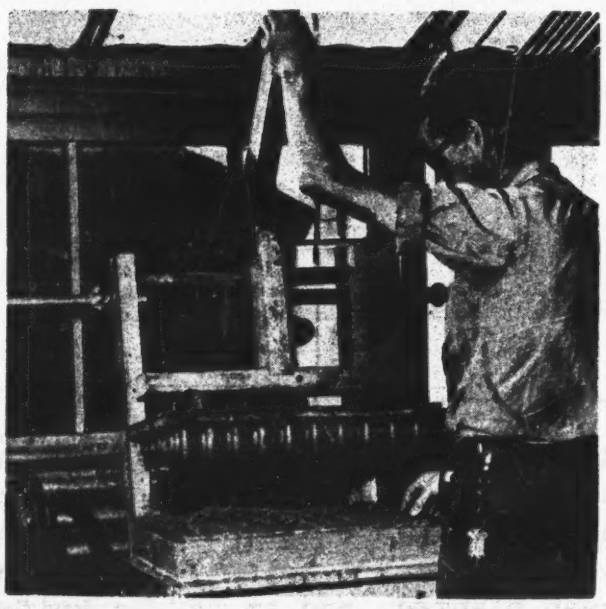
Flats are very simple to build. Therefore, they are sometimes used as beginning projects in shop. Skills that may be taught in the building of a flat are

1. Drawing and lettering
2. Measuring and marking wood
3. Cutting off a board using hand and power saws
4. Fastening wood

Plant boards

As shown in Picture 1, a planting board with evenly spaced pegs has been used to start holes for seedlings. These planting boards may be a simple board with rounded pegs or, for large operations, a device such as found in Picture 1 may be needed.

Picture 1



Pegboards, or "spotting boards", such as the one at left, are used to quickly make uniformly spaced holes for transplanting.

(Picture courtesy of Cooperative Extension Service, University of Illinois.)

The building of a planting board could include some other skills not used in the making of a flat. These other skills could be

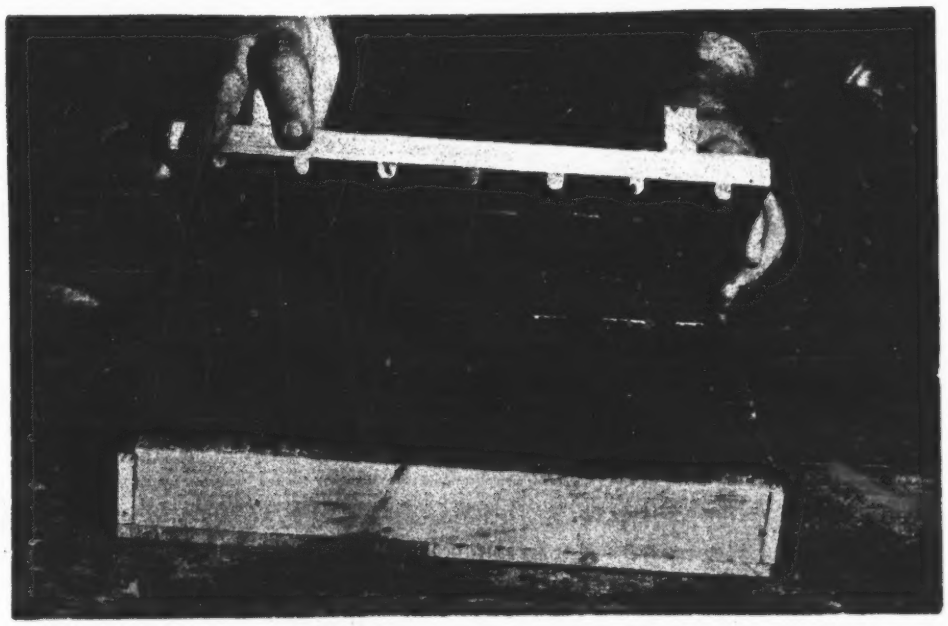
1. Boring and drilling holes in wood
2. Cutting with wood chisels
3. Countersinking
4. Shaping curved and irregular surfaces

Row marker

Another tool which makes better use of growing space is a row marker. As shown in Picture 2, rows or furrows are opened and the seed is sown thickly.

The building of a row marker involves skills which are mentioned earlier, but more time should be spent on proper spacing of the divider sections. An example of a row marker is given in Picture 2.

Picture 2



(Picture courtesy of Cooperative Extension Service, University of Illinois.)

Rows of uniform depth and spacing (above) can be quickly made with a row marker.

## Suggested Teaching-Learning Activities

1. Demonstrate how to draw a flat, planting board, and row marker
2. Demonstrate how to make out bills of materials for each project and figure the number of board feet in each.
3. Show filmstrip "Using a Crosscut Handsaw and Other Saws."
4. Have each student build a flat.
5. Show movie "Countersinking, Counterboring."
6. Divide the students into groups and have each group build a row marker or a planting board.

## Suggested Instructional Materials and References

### Instructional materials

1. Drawing and lettering equipment
2. Lumber, saws, hammers, nails, screws, etc. for projects
3. "Countersinking, Counterboring" 20 minutes, black and white, 16mm. film
4. "Using a Crosscut Handsaw and Other Saws," 46 frames, black and white filmstrip

### References

1. Christopher, E. P. Introductory Horticulture, pp. 158-159.
2. Edmond, J. B. et al., Fundamentals of Horticulture, p. 213.
3. Jones, Marck M. Shopwork on the Farm, pp. 40-112.

Suggested Occupational Experience

It is suggested that the teacher provide a major part, if not all, of the experience for this competency through the vocational agriculture shop or similar facilities. If student abilities and the type of training station available permit, some occupational experience may be given on a very limited basis.

Suggestions for Evaluating Educational Outcomes

The emphasis for evaluating this module should be placed on the doing part of the learning experience. Suggested areas of evaluation are:

1. Skill and ability in seeding flats. The following criteria may be used to evaluate student performance.

   a. Is the proper media used in the flat to be seeded?

   b. Is the flat filled level full with the media?

   c. Is the row marker used effectively?

   d. Is the seed sowed too deeply?

   e. Is the seed sowed too thickly? too sparsely?

   f. Is the flat properly watered and covered after the seeding is completed?

2. Evaluation of the student work in preparing cuttings.

   a. Are the cuttings of proper length?

   b. Are rooting hormones used?

   c. Is basal wounding performed on those cuttings requiring it?

   d. Are the cuttings "stuck" too deeply in the media?

   e. Are the cuttings properly spaced in the propagating bench?

   f. Does the student process an acceptable number of cuttings in a given period of time?

   g. Is the student conscientious about preparing the cuttings?

3. Does the student understand the method of choice (cuttings, layers, grafts or seed) for propagating the ornamental plants popular in the nurseries of the geographical area?

4. Does the student understand why many plants are propagated by various asexual means rather than being propagated by seed?

5. Evaluation of flat, planting board (dibble board) and row marker.

   a. Is the flat of proper size?

   b. Are the boards used in construction cut off squarely?

   c. Are the nails driven correctly such that the boards are not split or sharp projections allowed to remain which have the potential for causing injury to those handling the flat?

   d. Are the strips making up the row marker equally spaced and solidly nailed onto the frame?

6. Employer's evaluation of those who are placed in occupational work experience programs.

7. Oral quizzes and examinations as the opportunities present themselves to the teacher.

## Suggested Instructional Materials and References

### Instructional materials

1. "Countersinking, Counterboring," 16mm film, BW. West Virginia University Film Library, Morgantown, West Virginia. Minimum $.50 rental fee.

2. "Using a Crosscut Handsaw and Other Saws," BW filmstrip, 46 frames. Colonial Film and Equipment Company, 71 Walton Street, N. W., Atlanta, Georgia.

### References

1. Christopher, E. P. Introductory Horticulture, New York: McGraw-Hill Book Company, Inc., 1958.

2. Edmond, J. B. et. al., Fundamentals of Horticulture, New York: The Blackiston Company, Inc., 1953.

3. Hartman, Hudson T. and Dale E. Kester. Plant Propagation: Principles and Practices, Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1961.

4. Jones, Mack M. Shopwork on the Farm, New York: McGraw-Hill Book Company, Inc., 1955.

5. Mahlstede, John P. and Ernest S. Haber. Plant Propagation, New York: John Wiley and Sons, Inc., 1962.

6. Moon, Truman J., Paul B. Mann and James H. Otto. Modern Biology, New York: Henry Holt and Company, 1956.

7. Wells, James S. Plant Propagation Practices, New York: The MacMillan Company, 1964.

8. A Guide to Elementary School Gardening in Hawaii, Honolulu Hawaii: Hawaii Department of Public Instruction, Agricultural Education and Elementary Education, Department of Public Instruction, 1953.

THE CENTER FOR RESEARCH AND LEADERSHIP DEVELOPMENT
IN VOCATIONAL AND TECHNICAL EDUCATION
THE OHIO STATE UNIVERSITY
980 KINNEAR ROAD
COLUMBUS, OHIO, 43212

INSTRUCTOR NOTE: As soon as you have completed teaching each module, please record your reaction on this form and return to the above address.

1. Instructor's Name_____

2. Name of school_____State_____

3. Course outline used: _____Agriculture Supply--Sales and Service Occupations
_____Ornamental Horticulture--Service Occupations
_____Agricultural Machinery--Service Occupations

4. Name of module evaluated in this report_____

5. To what group (age and/or class description) was this material presented?____
_____

6. How many students:
a) Were enrolled in class (total) _____
b) Participated in studying this module _____
c) Participated in a related occupational work experience program while you taught this module _____

7.

| Actual time spent teaching module: | | Recommended time if you were to teach the module again: |
|---|---|---|
| _____hours | Classroom Instruction | _____hours |
| _____hours | Laboratory Experience | _____hours |
| _____hours | Occupational Experience (Average time for each student participating) | _____hours |
| _____hours | Total time | _____hours |

(RESPOND TO THE FOLLOWING STATEMENTS WITH A CHECK (✓) ALONG THE LINE TO INDICATE YOUR BEST ESTIMATE.)

| | VERY APPROPRIATE | NOT APPROPRIATE |
|---|---|---|
| 8. The suggested time allotments given with this module were: | | |
| 9. The suggestions for introducing this module were: | | |
| 10. The suggested competencies to be developed were: | | |
| 11. For your particular class situation, the level of subject matter content was: | | |
| 12. The Suggested Teaching-Learning Activities were: | | |
| 13. The Suggested Instructional Materials and References were: | | |
| 14. The Suggested Occupational Experiences were: | | |

(OVER)

15. Was the subject matter content sufficiently detailed to enable you to develop the desired degree of competency in the student? Yes_____No_____
Comments:

16. Was the subject matter content directly related to the type of occupational experience the student received? Yes_____No_____
Comments:

17. List any subject matter items which should be added or deleted:

18. List any additional instructional materials and references which you used or think appropriate:

19. List any additional Teaching-Learning Activities which you feel were particularly successful:

20. List any additional Occupational Work Experiences you used or feel appropriate:

21. What do you see as the major strength of this module?

22. What do you see as the major weakness of this module?

23. Other comments concerning this module:

_____ _____
(Date) (Instructor's Signature)

_____
(School Address)